BMP-28

BMP: SUBSURFACE DRAIN

Definition

A perforated conduit such as pipe, tubing or tile installed beneath the ground to intercept and convey ground water.

Purposes

1. To prevent sloping soils from becoming excessively wet and subject to sloughing.

2. To improve the quality of the growth medium in excessively wet areas by lowering the water table.

3. To drain stormwater detention areas or structures.

Conditions Where Practice Applies

Wherever excess water must be removed from the soil. The soil must be deep and permeable enough to allow an effective system to be installed. Either a gravity outlet must be available or pumping must be provided. These standards do not apply to foundation drains.

Planning Considerations

Subsurface drainage systems are of two types, relief drains and interceptor drains. Relief drains are used either to lower the water table in order to improve the growth of vegetation, or to remove surface water. They are installed along a slope and drain in the direction of the slope. They can be installed in a gridiron pattern, a herringbone pattern, or a random pattern (see Figure 28-1).

Interceptor drains are used to remove water as it seeps down a slope to prevent the soil from becoming saturated and subject to slippage. They are installed across a slope and drain to the side of the slope. They usually consist of a single pipe or series of single pipes instead of a patterned layout (see Figure 28-2).

FIGURE 28-1: SURFACE DRAIN OUTLET

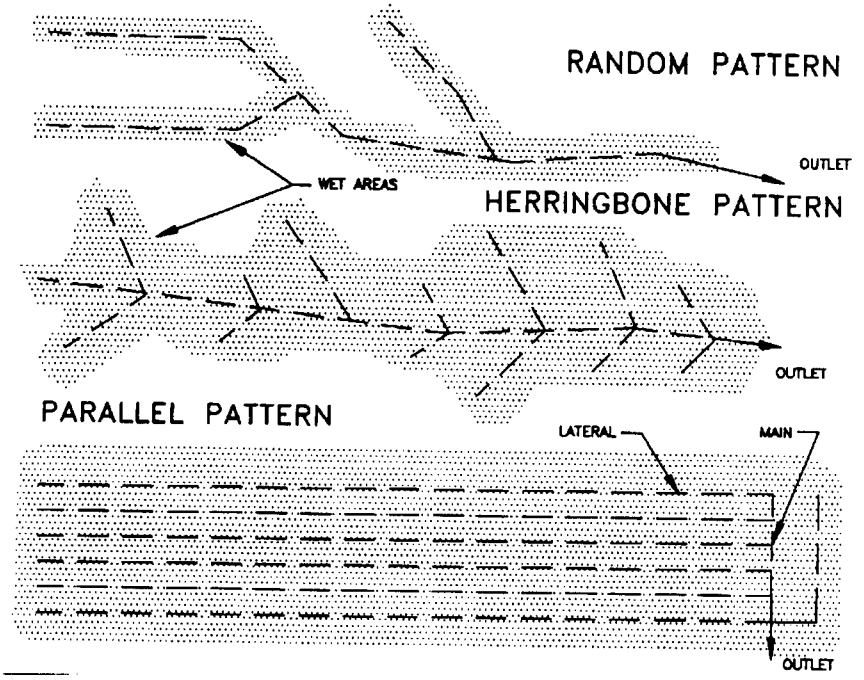
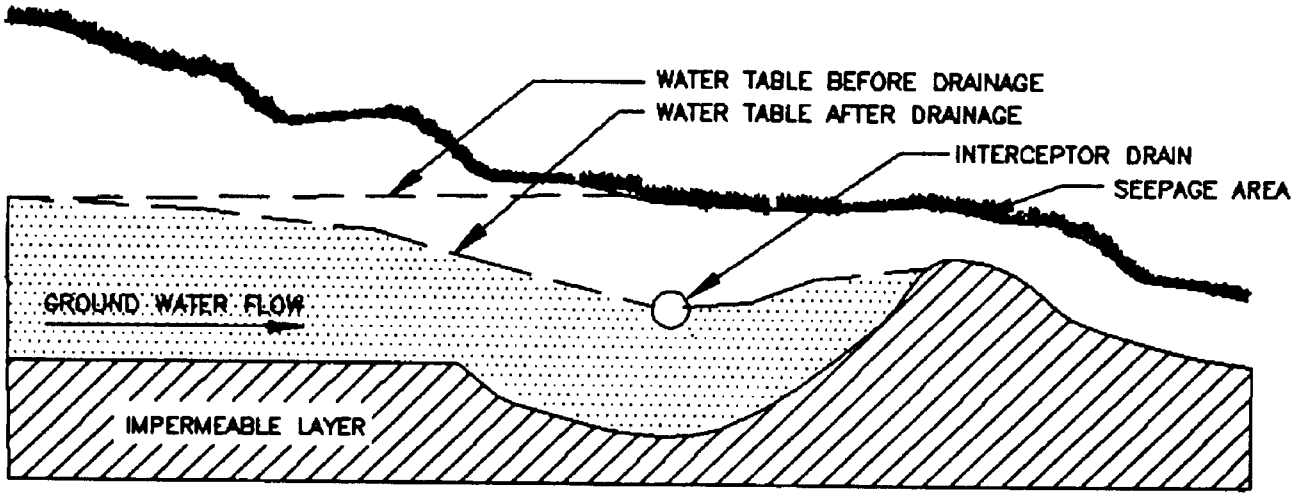


FIGURE 28-2: EFFECT OF SUBSURFACE DRAINAGE ON THE WATER TABLE



Design Criteria

Location -

Tree roots can often clog subsurface drain systems. Consequently, sub-surface drains should be located such that there are no trees within 15 meters (50 feet) of the drain.

Relief Drains - Relief drains should be located through the center of wet areas. They should drain in the same direction as the slope.

Interceptor drains - Interceptor drains should be located on the uphill side of wet areas. They should be installed across the slope and drain to the side of the slope.

Capacity of Drains -

The required capacity of a subsurface drain depends upon its use.

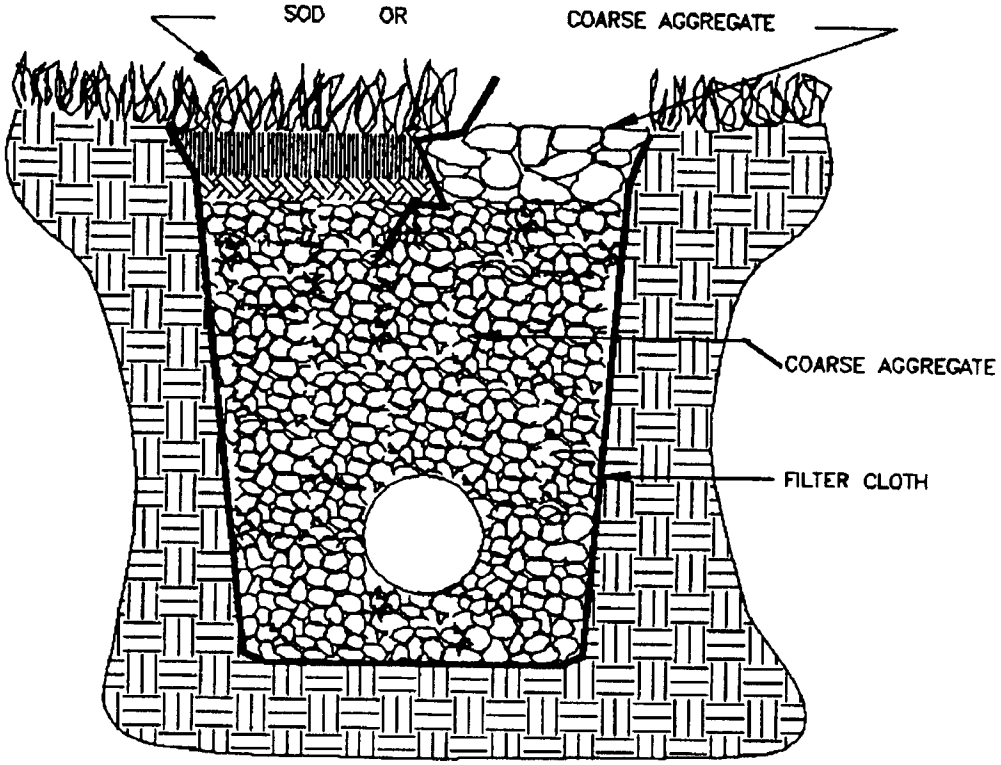
Relief Drains - Relief drains installed in a uniform pattern should remove a minimum of 25 millimeters (1 inch) of groundwater in 24 hours, approximately 0.003 cubic meters per hectare (0.042 cubic feet per acre). The design capacity must be increased accordingly to accommodate any surface water which enters directly into the system (see Figure 28-3).

Intercepts - Interceptor drains or relief drains installed in a random pattern should remove a minimum of 0.1 cubic meters per second per 1000 meter of length (1.5 cfs/1000 feet of length). This value should be increased for sloping land according to the values in Table 28-1. In addition, if a flowing spring or surface water enters directly into **the** system, this flow must be accommodated and the design capacity must be increased accordingly to take care of this flow (see Figure 28-4).

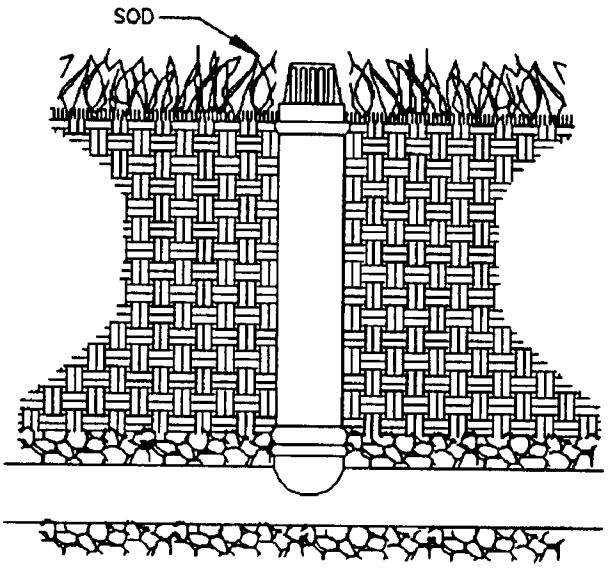
TABLE 28-1
WATER REMOVAL RATES FOR SLOPING LAND*

Land Slope	Water Removal Rates in cubic meters per second (cms) per 1000 meters (m)	
2 - 5%	0.15 cms/1000 m	1.65 cfs/1000 ft
6 - 12%	0.17 cms/1000 m	1.80 cfs/1000 ft
> 12%	0.18 cms/1000 m	1.95 cfs/1000 ft
* These rates depend on the soil types where the drains are installed. Heavier soils may result in slower water removal rates.		

FIGURE 28-3: SURFACE INLETS



NATURAL INLET



GRATED INLET

Size of Drains-

Subsurface drains should be sized for the required capacity using Table 28-4 and 28-5 in Appendix BMP28-a. The minimum diameter for a subsurface drain shall be 100 millimeters (4 inches).

Depth and Spacing -

Relief Drains - Relief drains installed in a uniform pattern should have equal spacing between drains and the drains should be at the same depth. Maximum depth is limited by the allowable load on the pipe, depth to impermeable layers in the soil, and outlet requirements. The minimum depth is 0.6 meters (2 foot) under normal conditions. The 0.6 meter depth is acceptable where the drain will not be subject to equipment loading or frost action. Spacing between drains is dependent on soil permeability and the depth of the drain. In general, however, a depth of 1 meter (3 feet) and a spacing of 15 meters (50 feet) will be adequate. A more economical system may be designed, if the necessary information is available, by using the equations found in Appendix 28-a.

Interceptor drain - The depth of installation of an interceptor drain is influenced mainly by the depth to which the water table is to be lowered. The maximum depth is limited by the allowable load on the pipe and the depth to an impermeable layer. Minimum depth should be the same as for relief drains.

One interceptor drain is usually sufficient. However, if multiple drains are to be used, determining the required spacing can be difficult. The best approach is to install the first drain - then if seepage or high water table problems occur downslope, install an additional drain a suitable distance downslope. This distance can be calculated from equations found in Appendix 28-a.

Velocity and Grade -

The minimum velocity required to prevent silting is 0.4 meters/sec (1.4 ft/sec). The line should be graded to achieve at least this velocity. Steep grades should be avoided. Table 28-2 lists maximum velocities for various soil textures.

Envelopes -

Envelopes shall be used around all drains for proper bedding and improved flow of groundwater into the drain. The envelope shall consist of 75 millimeters (3 inches) of aggregate placed completely around the drain. The stone shall be encompassed by a filter cloth separator in order to prevent the migration of surrounding soil particles into the drain (see Figure 28-4). Filter cloth must meet the physical requirements noted in BMP-19, RIPRAP.

TABLE 28-2
MAXIMUM VELOCITIES FOR VARIOUS SOIL TEXTURES

Soil Texture	Maximum Velocity	
	meters per second	feet per second
Sandy and Sandy Loam	1.1	3.5
Silt and Silt Loam	1.5	5.0
Silty Clay Loam	1.8	6.0
Clay and Clay Loam	2.1	7.0
Coarse Sand or Gravel	2.7	9.0

Surface Water -

Figure 28-3 shows two types of surface water inlets. The grated inlet should not be used where excessive sedimentation might be a problem.

Outlet -
The outlet of the subsurface drain shall empty into a channel or some other watercourse which will remove the water from the outlet. It shall be above the mean water level in the receiving channel. It shall be protected from erosion, undermining, damage from periods of submergence, and the entry of small animals into the drain.

The outlet shall consist of a 3 meter (10-foot) section of corrugated metal, cast iron, steel or schedule 40 PVC pipe without perforations. No envelope material shall be used around the pipe. At least two-thirds of the outlet pipe length shall be buried.

Materials -

Acceptable materials for subsurface drains include perforated, continuous closed-joint conduits of corrugated plastic, concrete, corrugated metal, asbestos cement, and bituminous fiber. The strength and durability of the pipe shall meet the requirements of the site in accordance with the manufacturers specifications.

Construction Specifications

1. The trench shall be constructed on a continuous grade with no reverse grades or low spots.

2. Soft or yielding soils under the drain shall be stabilized with gravel or other suitable material.

3. Deformed, warped, or otherwise unsuitable pipe shall not be used.

4. Envelopes or filter material shall be placed as specified with at least 75 millimeters (3 inches) of material on all sides of the pipe.

5. Backfilling shall be done immediately after placement of the pipe. No sections of pipe should remain uncovered overnight or during a rainstorm. Backfill material shall be placed in the trench in such a manner that the drain pipe is not displaced or damaged.

6. The outlet section of the drain shall consist of at least 3 meters (10 feet) of non-perforated corrugated metal, cast iron, steel or schedule 40 PVC pipe. At least two-thirds of its length shall be buried.

Maintenance

1. Subsurface drains should be checked periodically to ensure that they are free-flowing and not clogged with sediment.

2. The outlet should be kept clean and free of debris.

3. Surface inlets should be kept open and free of sediment and other debris.

4. Trees located too close to a subsurface drain often clog the system with their roots. If a drain becomes clogged, relocate the drain or remove the trees.

5. Where drains are crossed by heavy vehicles, the line should be checked to ensure that it is not crushed.